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STUDY OF THE REAL SHAPE OF COMET'S HUMASON 1961 e TAIL

by

G. Guigay

(FRANCE)

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From Author's Manuscript by G. GUIGAY

ABSTRACT

This is a study of a series of photographs of the Humason comet taken at the Haute-Provence Observatory between 20 August and 6 September 1962 by MM. Dossin and J. Dufay.

Examination of these photographs shows that the tail swings on either side of the projection of radius-vector. It is noted in particular that it is situated AHEAD of the radius-vector relative to comet's motion from 23 to 26 August and from 29 August to 5 September. Moreover, the photographs of 25 and 28 August are remarkable, the first one because of the presence of double lateral jets stemming from the tail, the second — by the curvature of its tail and the presence of spires.

The shape of the tail presumed developed in the orbit plane has been determined by the Stumpff method. Despite very unfavorable projection conditions (the Earth then being in the vicinity of the comet's orbit plane while the latter was in the opposition with the Sun) these calculations confirm the direction of the tail TOWARD THE FRONT for the dates 1962 — September 3.897 and 1962 September 5.897. If the development of the tail is due to solar corpuscles, the latter can not move radially; as of the Sun their heliocentric velocity vector must constitute an angle of 10 to 15° with the radial direction.

** * **

1. - Following is the study of the direction of comet's Humason tail, performed with the help of a series of photographs taken from the Haute-Provence Observatory by Mr. Dossin and subsequently by M. J. Dufay from 20 August to 5 September 1962, and which were communicated to me for that purpose.

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* Etude de la forme réelle de la queue de la comète Humason 1961 e.

The following has been marked on the photographs reproduced in the plates I and II :

1) the direction at the North N,

2) the great circle passing through the Sun and the comet, on which the direction at the Sun is marked by the sign ⊙, and the opposite direction by the sign V. The latter is that of the projection on the plane perpendicular to the visual ray of the extended comet's radius-vector (for the sake of clarity all the photographs were so oriented that the letter V be on top).

3) the direction D of the apparent motion of the comet.

The examination of these photographs shows a balancing (swinging) of the tail, at one time ahead of radius-vector's projection relative to comet's motion, at another time in the rear.

Table I gives :

1) the number of the negative,

2) the date and the time at the middle of the exposure (UT),

3) the angle φ between the projection of the extended radius-vector and the direction of the apparent axis of the tail. This angle is counted positively when the axis of the tail is directed <u>to the rear</u> of the extended radius-vector relative to the motion.

In the last column this case is indicated by REAR, the inverse one by FR (front).

The graph of Fig. 1 shows these direction variations and discloses a period of the order of 5.5 days, possibly linked with a rotation of the tail.

The photograph S 1247 of 25 August, reproduced in Plate III, shows an expulsion of matter toward the right, simultaneously from the head and from the tail; these jets seem to be double. Noted also should be the strong curvature of the tail on the photograph S 1255 (plate IV) and the presence of spires on this negative.

[Follows Table I]

TABLE 1

Negative	Date 1962	φ	Direction
S 1214	Aug. 20.894	39°	REAR
S 1218	21.885	44°	REAR
S 1224	22.942	22.5°	REAR
S 1230	23.931	−18°	FR
S 1240	24.949	−15°	FR
S 1247	26.024	− 13.5°	FR
S 1250	26.863	− 11.5°	FR
S 1252	27.899	33.5°	REAR
S 1255	28.854	curved tail with spires	
S 1256	29.854	−34°	FR
S 1259	31.071	− 12°	FR
S 1261	Sep. 1.867	− 7°	FR
S 1262	2.865	− 18.5°	FR
S 1264	3.897	− 20°	FR
S 1265	5.897	− 5°	FR
S 1266	6.922	0°	

* * *

II. - A more precise study of the shape of the tail is unfortunately beset with great difficulties. The observation of a comet provides us only with its projection on the plane perpendicular to the visual ray and the passage to the real shape is an indeterminate problem. The question was resolved by admitting that the tail is developed in the orbit plane and methods due to Bessel, and more recently to Stumpff, have allowed to determine the real shape of the tail by this hypothesis. Unfortunately, the Earth was in the vicinity of comet's orbit plane during the entire period covered by these negatives. Even at the end of the observation period, on 5 September, the latitude of the Earth relative to that plane did not exceed 2.5°, whereas it was only of 4' on 29 August, at time of making the negative 1255, the most interesting for the curvature of the tail and the presence of spires. Moreover, the comet was sensibly in the opposition with the Sun. These very unfavorable conditions are illustrated in Fig. 2, borrowed from Sky and Telescope. The calculation of the true shape of the tail has nevertheless been computed with the aid of the CAB 500 of the Marseille Observatory by the Stumpff method * for the least unfavorable cases at the end of the observation period.

P. STUMPFF.- A. N. 283 - 285, 1959.

.COMETE.HUMASON.

POSITION DE LA QUEUE

(Position of the Tail)

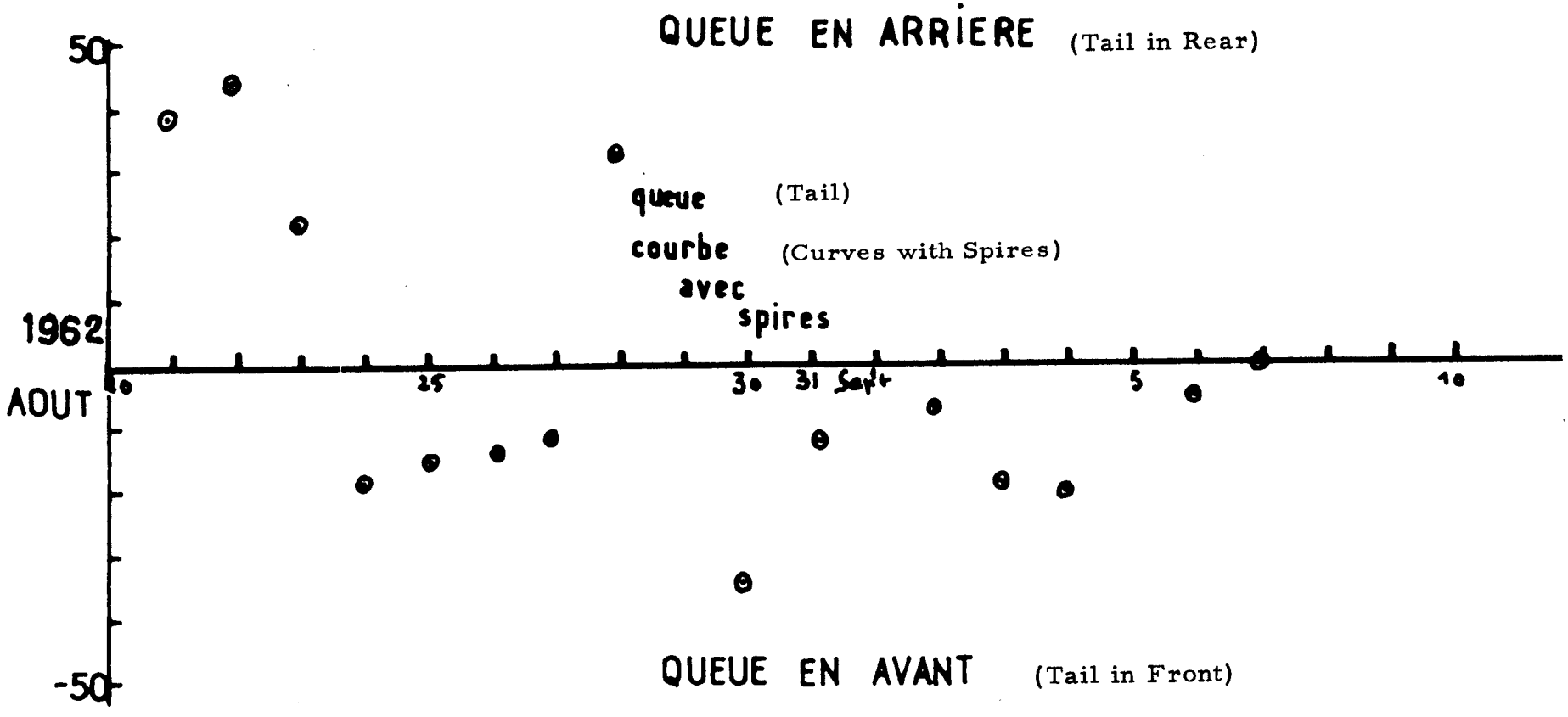

Fig. 1

Figures 3 and 4 respectively reproduce the results for the negatives S 1264 of 3 Septmber and S 1265 of 5 September 1962. Shown also in these figures are the direction of the Earth and its latitude relative to the orbit plane of the comet. Besides, I represented in Fig. 4 the comet in a plane perpendicular to the visual ray, as one observes it. This last representation has been shifted in the direction of the Earth, so as to avoid the entanglement of the figures. The Earth is slightly below the orbit plane.

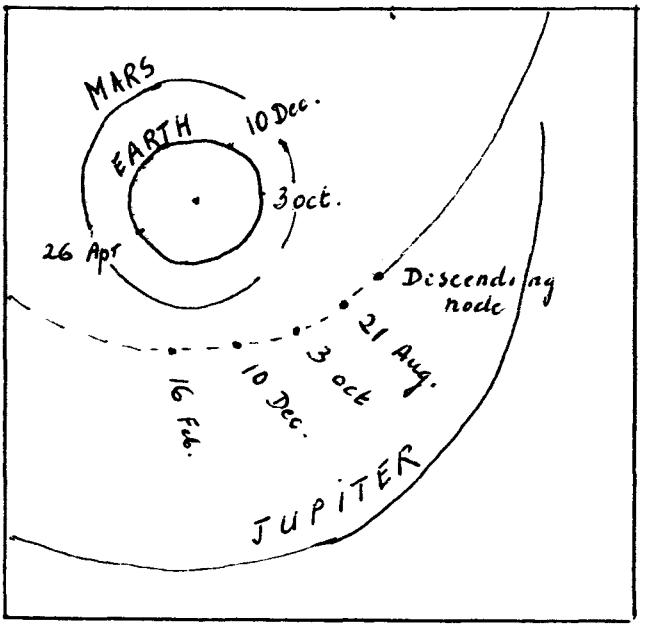

Fig. 2

At time of their projection over this last plane, the points of the comet which are also somewhat below that plane are being projected in the rear of the nucleus, whereas those which are above are being projected forward, and the distances are exagerated in both, the direction of the Earth and the opposite one. The asterisks of Fig. 4 correspond to the projection of points situated on the apparent axis of the tail; they provide the real axis of the latter and show that this axis is curved and directed relative to the radius-vector on the same side as the velocity vector V of the comet.

The forward direction of the axis of the tail calls for a remark on the corpuscular fluxes of the Sun, to which modern theories attribute the formation of gazeous tails of comets (it is well known that the tail of the

-S.1264-

COMETE HUMASON 1961 e
1962 SEPTEMBRE 3,897

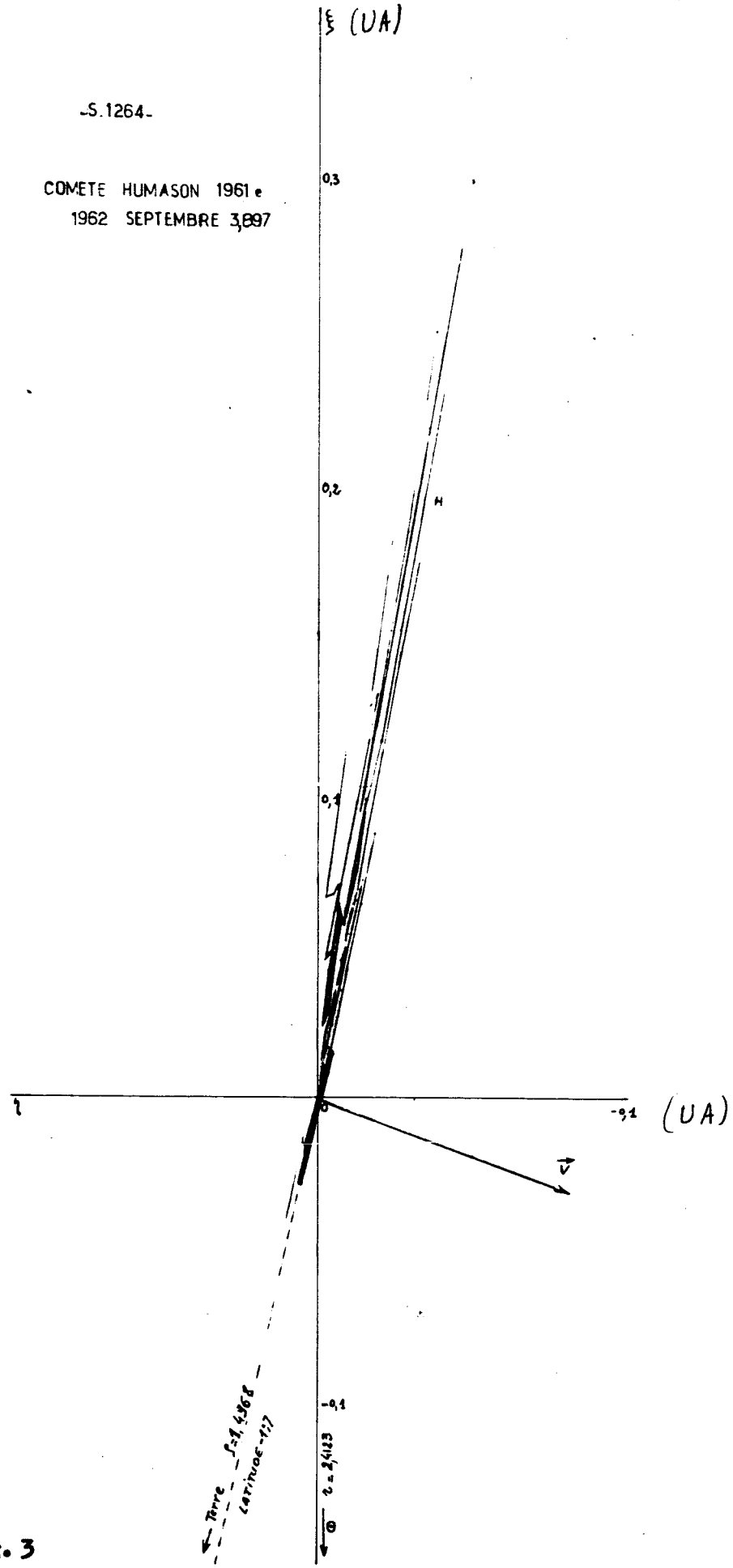

Fig. 3

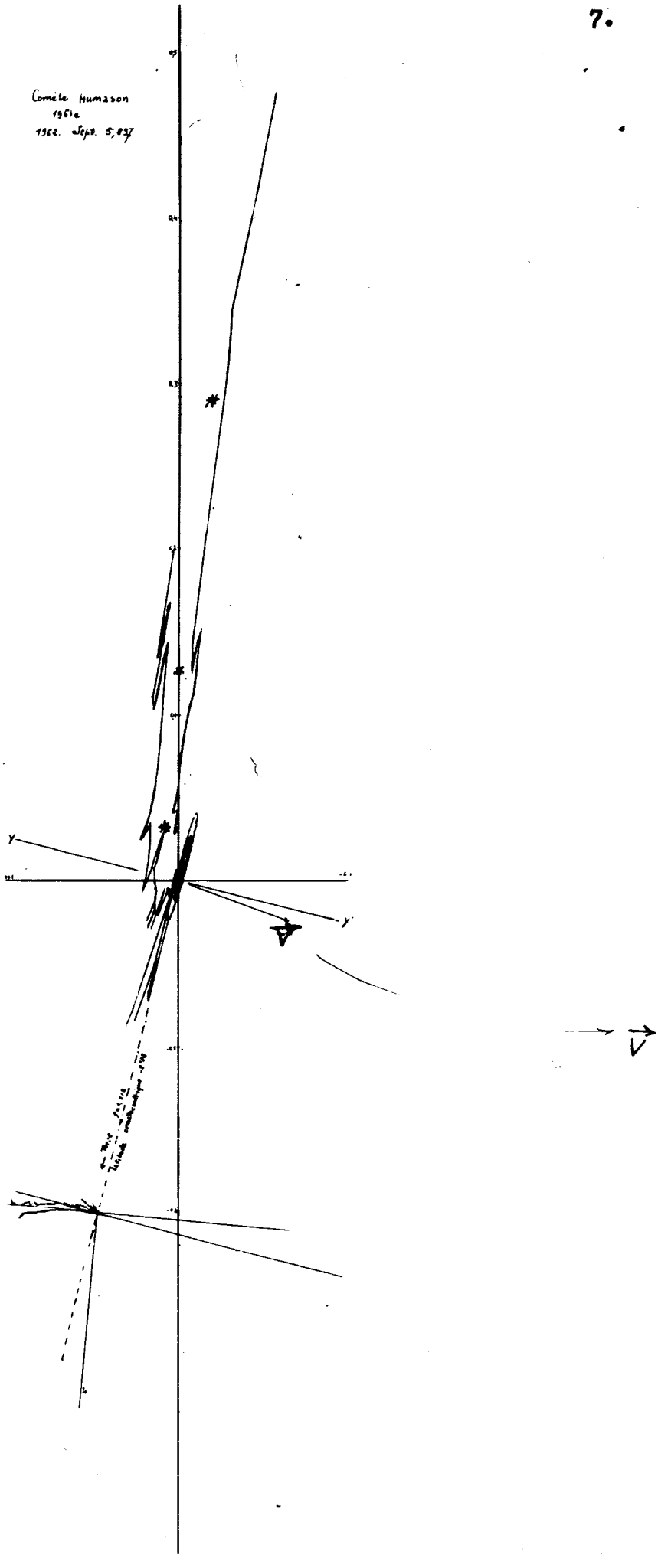

Fig. 4

Humason comet belongs to that category). According to the Alfvén theory, a current of corpuscles of solar origin, containing a "frozen-in" magnetic field (Fig. 5) encounters the comet. Then the lines of force are frozen in the coma, when in the lateral parts these same lines, carried by the current, pursue their motion. On the other hand, the magnetic field being frozen inside the matter, the latter is carried in the motion of the lines of force, whence the formation of the tail. The axis of the latter corresponds to the relative velocity of particles relative to the comet. But then, the compounding of this particle velocity with that of the comet can not provide a tail directed toward the front if the particles move radially relative to the Sun. I have determined the shift necessary for the radiality to explain the obtained direction of the tail.

Assume (Fig. 6) that in the orbital plane of the comet N is the comet's nucleus, $N\xi$ is the extended radius-vector Sun - nucleus, NX is the axis of the tail, $\vec{V}$ is the heliocentrical velocity vector of the comet, $\vec{v}$ is the heliocentrical velocity vecotr of particles, which is obtained by adding to the vector $\vec{V}$ their relative velocity $\vec{v}_r$, borne by NX.

φ is the angle XNV between $NX\xi$ and the velocity vector V of the comet; the angle φ is measured on the figure providing the representation of the comet in its orbit plane (Fig. 3 and 4]; ε is the angle ξNX between the radius-vector extended, and the axis of the tail.

Various values are attributed to the velocity v of particles, which correspond to admitted values for the solar wind and the solar corpuscular streams, that is, values comprised between 200 and 1 600 km.sec. The velocity V of the comet is taken equal to the parabolic velocity. The angle x between the direction of the axis of the tail, that is, the relative velocity of particles, and their heliocentrical velocity, is given by:

$$\sin x = \frac{V}{v} \sin \varphi \qquad (1)$$

and the radiality particle shift by

$$\delta = \varphi + \varepsilon \qquad (2)$$

The calculations were performed for the negatives S 1264 and S 1265. For S 1264, we have

$$r = 2.4123; \quad V = 27.04 \text{ km/sec (we take } V = 27 \text{ km/sec)}$$
$$\varphi = 101^\circ; \quad \sin \varphi = 0.982; \quad x = 9.5^\circ.$$

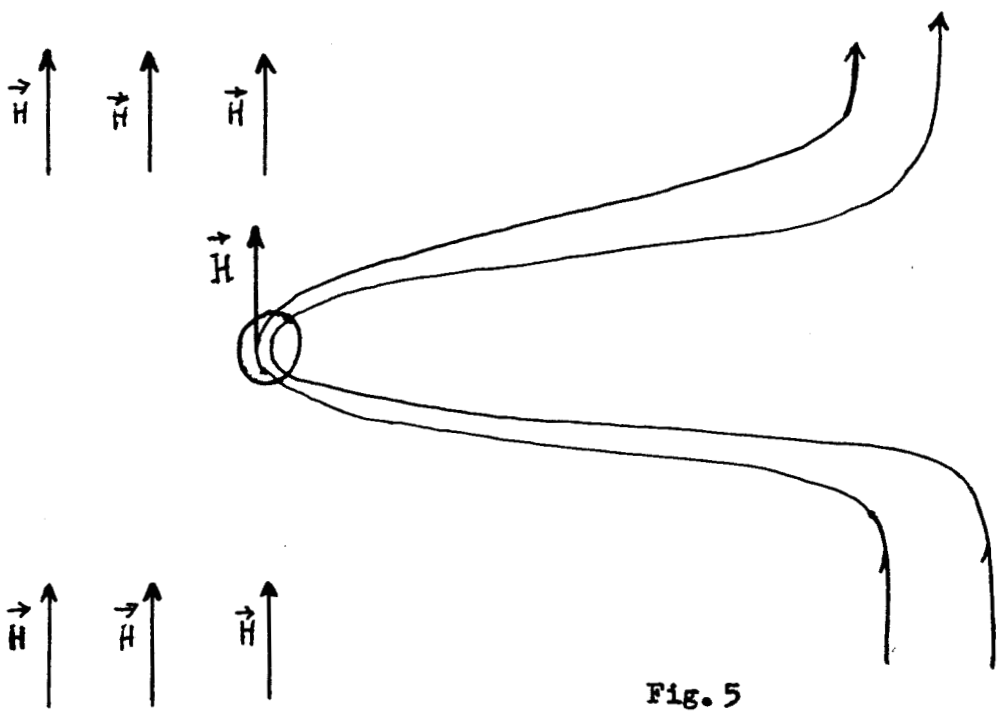
$\vec{H}$
$\vec{H}$
$\vec{H}$
$\vec{H}$
$\vec{H}$
$\vec{H}$
$\vec{H}$

Fig. 5

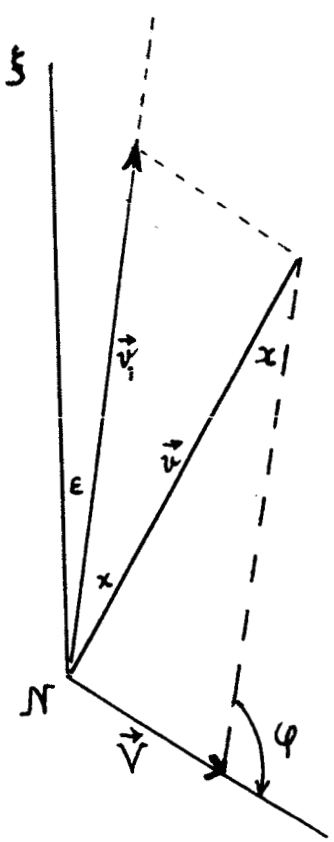
ξ
$\vec{\psi}_1$
$\vec{\psi}$
ε
x
x
N
$\vec{V}$
φ

Fig. 6

The computation stages relative to the negative S 1264 are reproduced in the first five columns of Table II.

For the negative S 1265 we have :

$r = 2.4018$; $V = 26.99$ km/sec, that is still 27 km/sec;

$\varphi = 103.5^\circ$; $\sin \varphi = 0.973$; $\varepsilon = 6^\circ$.

$\frac{V}{v}$ has the same values as for S 1264. The quantities x and δ relative to S 1265 are given in the last two columns of Table II hereafter.

TABLE II

	S 1264			S 1265	
v km/sec	$\frac{V}{v}$	x	δ	x	δ
200	0.135	7.6°	17.1°	7.6°	13.6°
400	0.068	3.8°	13.3°	3.8°	9.8°
600	0.045	2.5°	12.0°	2.5°	8.5°
800	0.034	1.9°	11.4°	1.9°	7.9°
1 000	0.027	1.5°	11.0°	1.5°	7.5°
1 200	0.023	1.3°	10.8°	1.3°	7.3°
1 400	0.019	1.1°	10.6°	1.1°	7.1°
1 600	0.017	1.0°	10.5°	0.9°	6.9°

If we adhere to velocities of 300 and 500 km/sec corresponding to the solar wind, we are led to admit a shift of 10 to 15 degrees between the direction arriving directly from the Sun and the direction of motion of solar particles.

**** THE END ****

Contract No.NAS-5-3760
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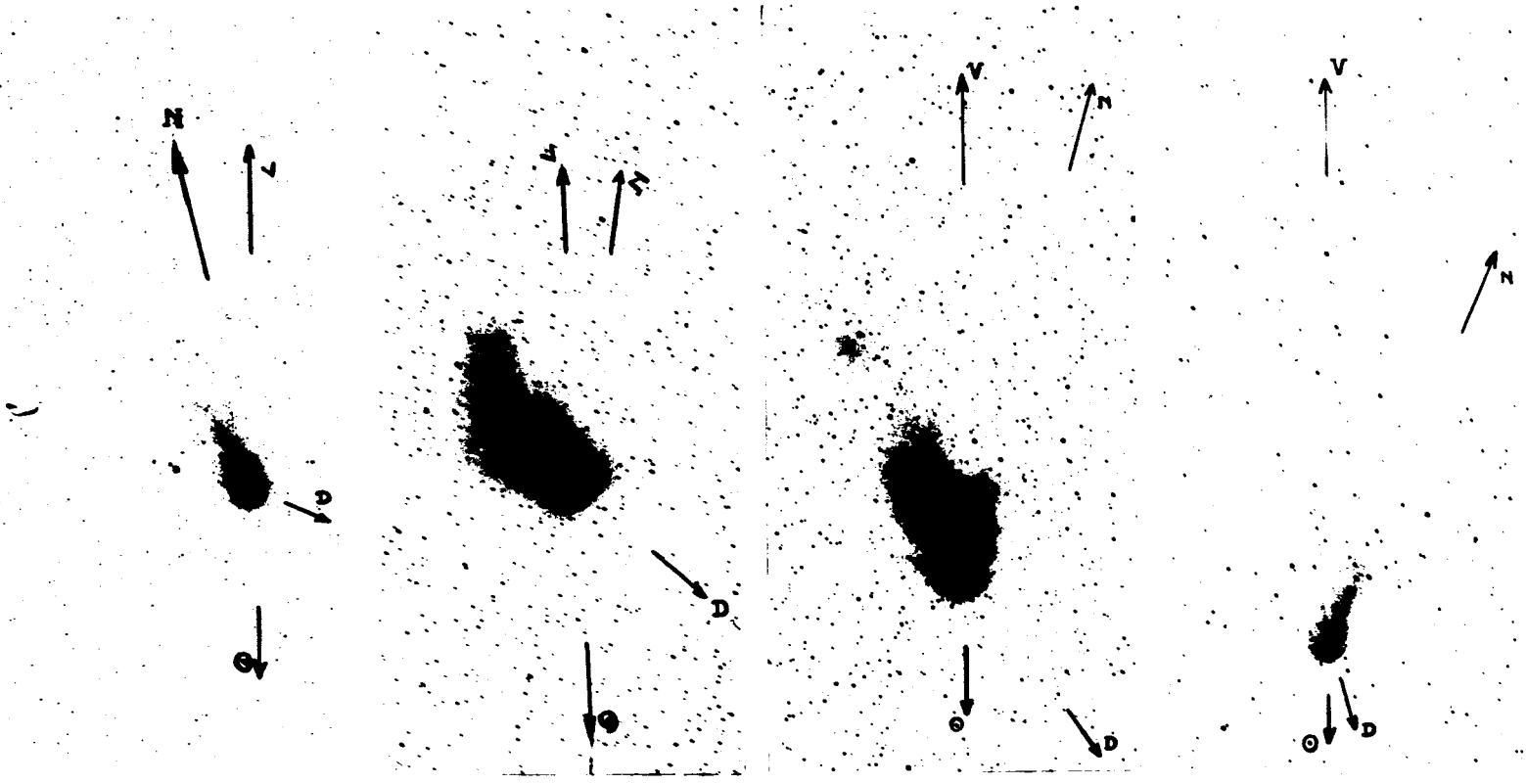
Translated by ANDRE L. BRICHANT
on 12 — 13 February 1966

OBSERVATOIRE DE HAUTE-PROVENCE. COMET HUMASON 1961 e

Plate I



1962 AOUT 20,894 — 1962 AOUT 21,885 — 1962 AOUT 22,942 — 1962 AOUT 23,931

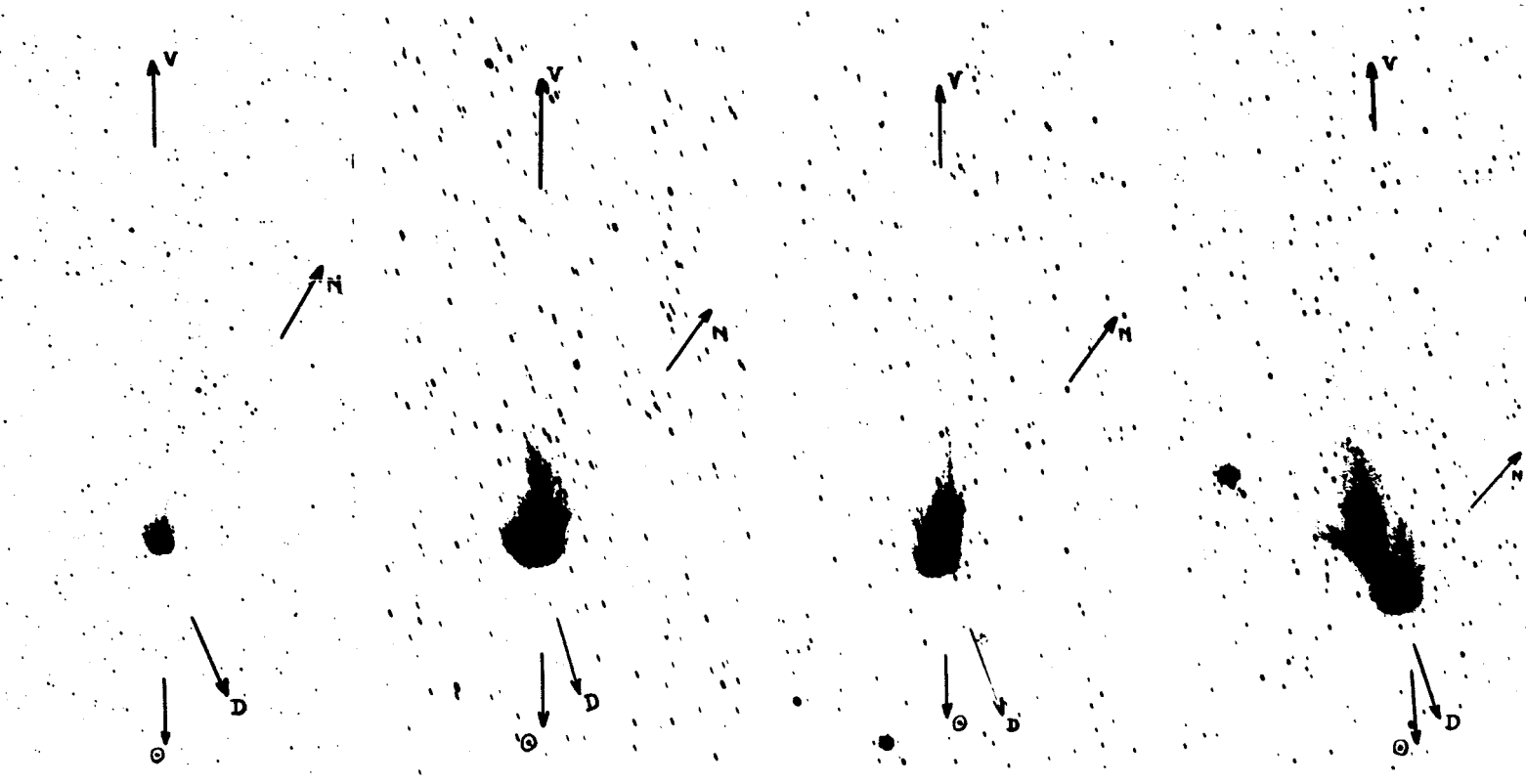
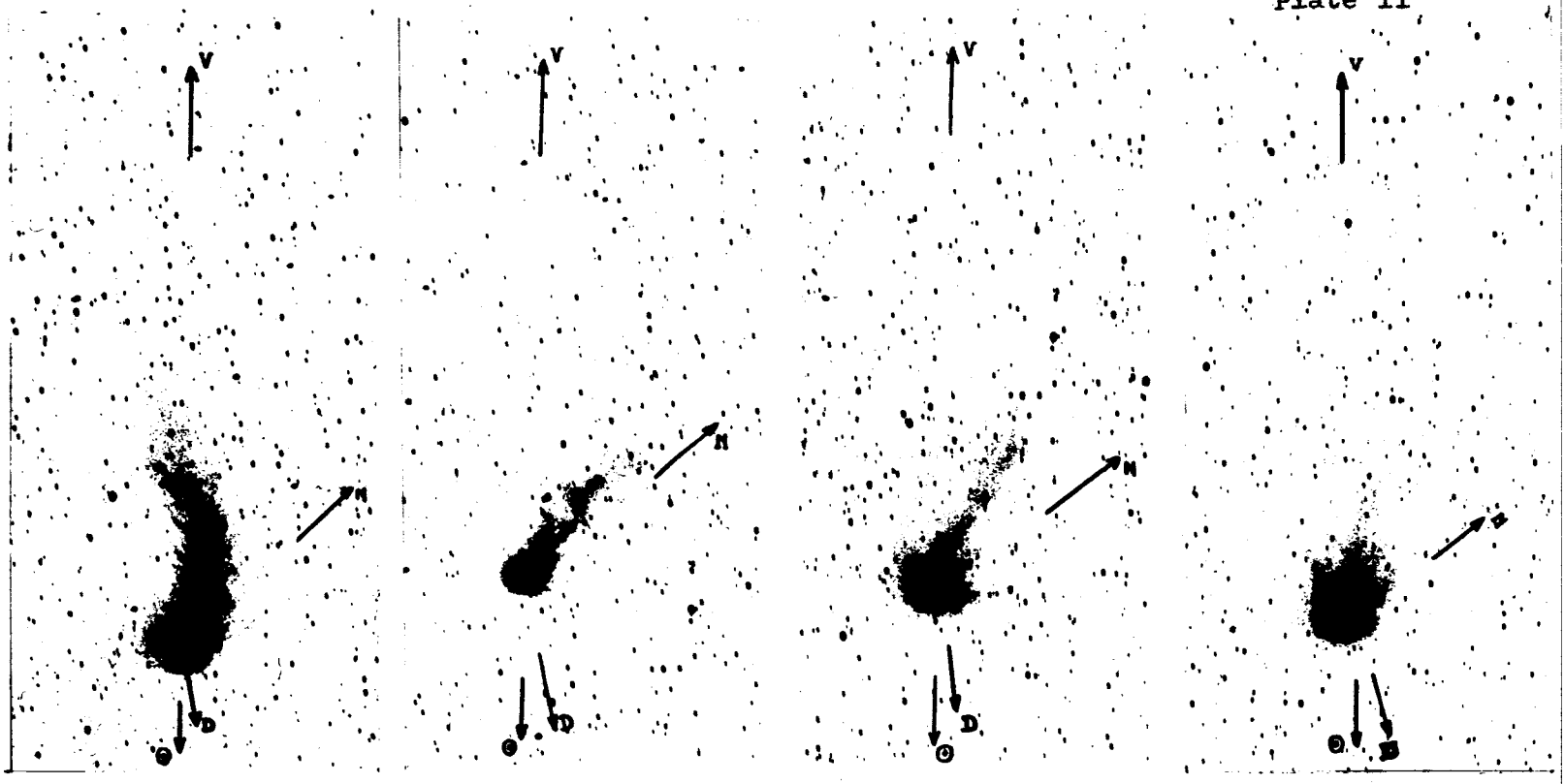
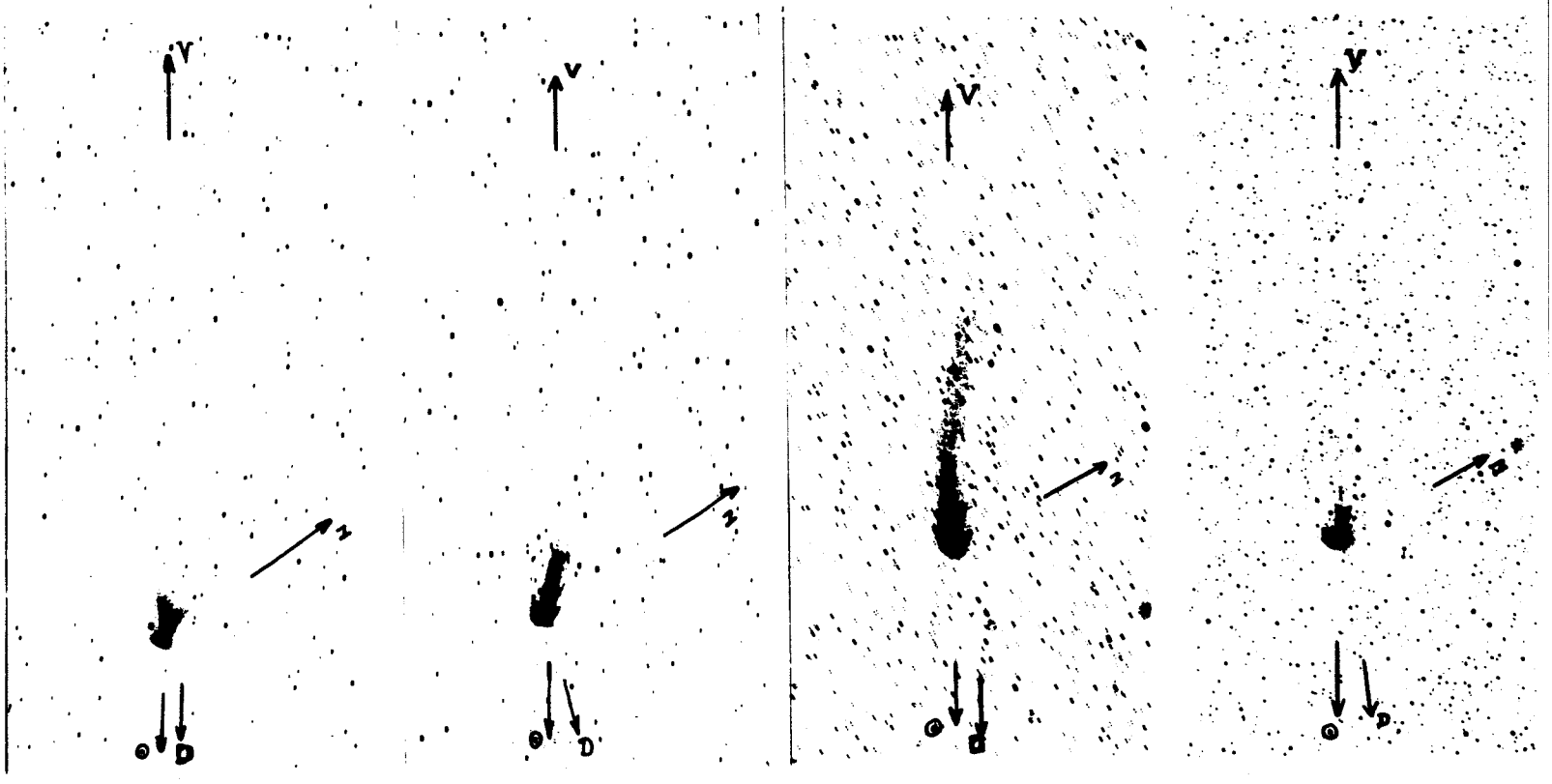


Plate II



S 1255 S 1256 S 1259 S 1261

1962 AOUT 28,854 — 1962 AOUT 29,854 — 1962 AOUT 31,071 — 1962 SEPTEMBRE 1,867



S 1262 S 1264 S 1265 S 1266

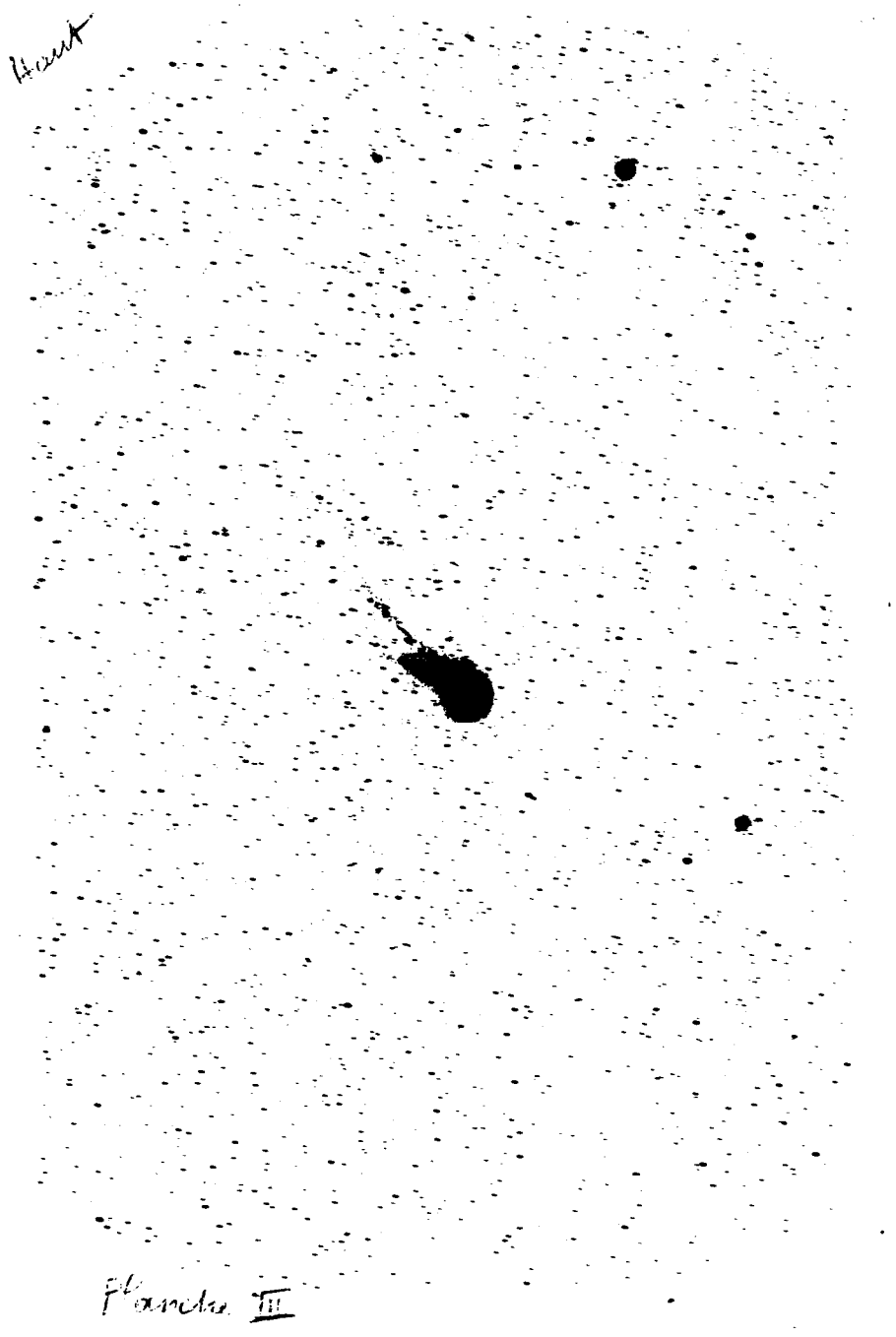


Planche III

PLATE III

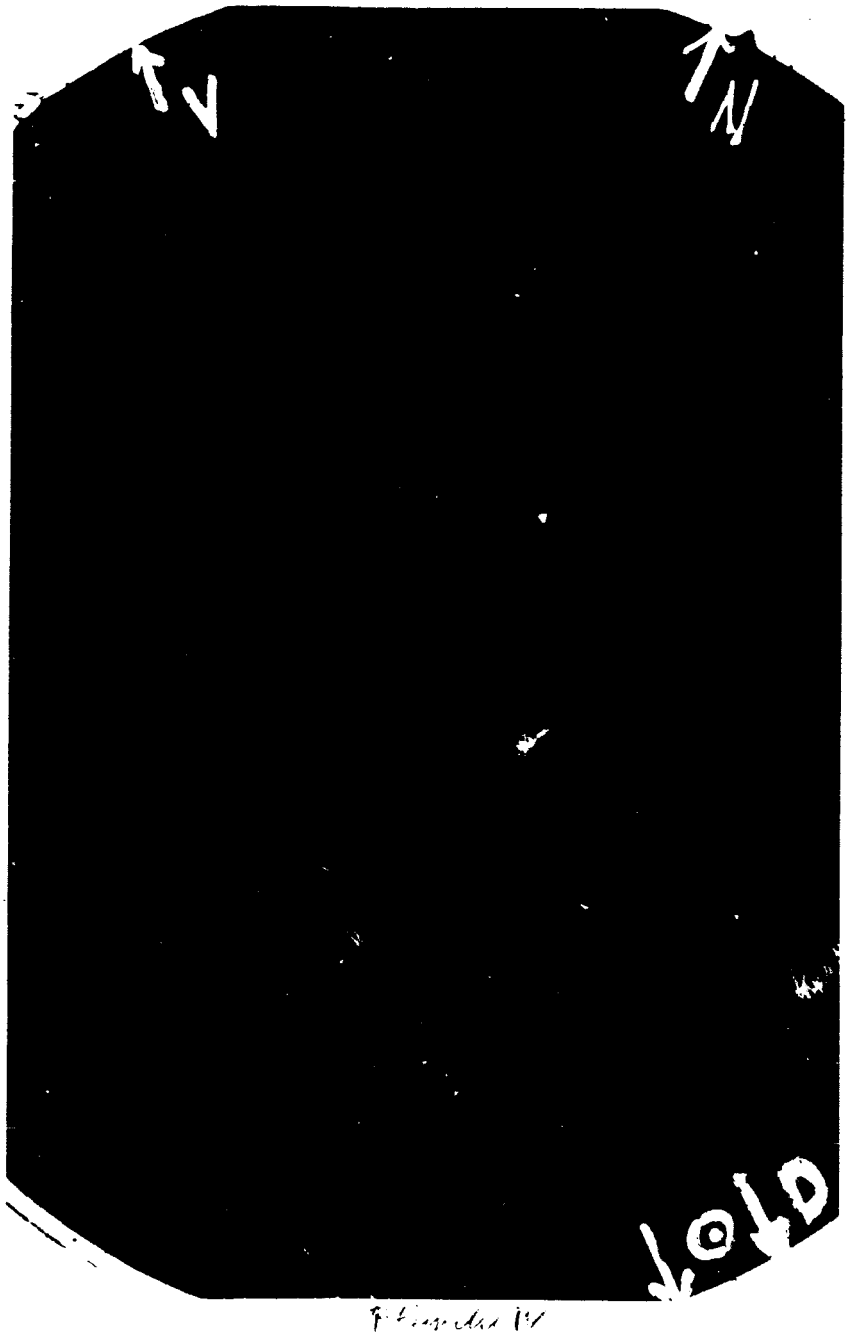


PLATE IV

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